EAGLE FATALITY ANNUAL MONITORING REPORT
YEAR 2, SHILOH IV WIND PROJECT
Solano County, California

November 2016

Prepared for:

Shiloh IV Lessee, LLC

Prepared by:
CURRY & KERLINGER, LLC

Paul Kerlinger, Ph.D.
Richard Curry, Ph.D.
Aaron Hasch
John Guarnaccia

Curry and Kerlinger, LLC
1734 Susquehannock Drive
McLean, VA. 22101
703-821-1404, fax-703-821-1366
RCA1817@aol.com

Executive Summary

Herein, we provide the results of a second year of monthly eagle fatality monitoring (19 October 2015 to 30 September 2016) for the Shiloh IV Wind Project, located in the Montezuma Hills Wind Resource Area (MHWRA) in Solano County, California, and compare them with the first year's results (13 September 2014 to 22 August 2015), reported previously. This monitoring was required as a condition of the Shiloh IV Eagle Take Programmatic Permit MB67633A-0 that the U.S. Fish and Wildlife Service (hereafter, the Service) issued in July 2014. The permit allows the take of a total of five Golden Eagles over five years during operations and maintenance activities. An Eagle Conservation Plan (ECP) detailed post-construction monitoring activities per the permit.

Fatality monitoring was designed to maximize detection probability of Golden Eagles. This was accomplished by searching all turbines monthly (a total of 1,200 searches in two annual periods) out to 120 m, nearly the maximum distance that a ballistics model predicted that a large bird, having collided with a wind turbine, would be distributed. Transect spacing depended on vegetation height. When vegetation was short, i.e., ≤ 15 cm (≤ 6 inches) in height, transects were spaced at 20 m, 60 m, and 100 m from turbines, with searchers searching 20 m on each side of transects. When vegetation was tall, i.e., > 15 cm (> 6 inches) in height, the spacing between transects was reduced to improve detectability, with transects located at 10 m, 30 m, 50 m, 70 m, 90 m, and 110 m from turbines and searchers searching 10 m on each side of transects.

The first year and a half of this study (September 2014 to February 2016), however, overlapped with a required bird and bat fatality study at Shiloh IV that employed weekly searches of 25 of the 50 turbines. During the overlap period, turbines in weekly rotation were searched along 13 circular transects, the spacing of which did not depend on vegetation height. Transects were spaced at 10 m apart from 100 m to 30 m from turbine bases and 5 m apart between 30 m and 5 m from turbine bases. Teams of 2-4 searchers used range finders to estimate distances from turbines and recheck them periodically. To search those turbines out to 120 m for the eagle fatality study, an additional transect was added during the week when eagle searches were conducted.

Previously collected data were used to check search efficiency (SE) and carcass persistence (CP) rates, but in year 2 of this study, those data were augmented with additional SE and CP sampling conducted in 3 and 6-transect search plots. This allowed us to differentiate SE in 3, 6, and 14-transect search plots and extend CP data from 14 to 60 days. SE and CP were sampled using surrogates for Golden Eagles, namely, Red-tailed Hawks, Turkey Vultures and Great Horned Owls collected in MHWRA fatality studies. Given that Golden Eagles are considerably bulkier than those surrogates, making them easier for searchers to find and more difficult for scavengers to remove, the SE and CP rates reported herein are conservative.

No evidence of eagle take was detected during the two months before and the month between the two 12-month eagle monitoring periods. In addition, any incidental finds by project operations and maintenance staff would have been called to the attention of biologist searchers. Consequently, the results of this study cover more than 24 months of eagle fatality monitoring at the facility. Based on the amount of eagle protocol searching, the opportunities for incidental

finds, and the absence of any evidence of eagle mortality or injury, it appears that no take of eagles occurred at the Shiloh IV facility.

Based on the allowed take of five eagles in five years, it is unlikely this level of take will be exceeded. In addition, the Shiloh IV eagle take permit contains Experimental Advanced Conservation Measures using a stepwise approach (Attachment 3, Table 4-1) that outlines additional measures to be considered if take below the maximum limit is detected. Based on the stepwise triggers, no additional Experimental Advanced Conservation Measures are warranted.

Table of Contents

Figures

Tables

Figure 1. Location of the Shiloh IV Wind Project (yellow polygons) in the MHWRA, Solano County, California.

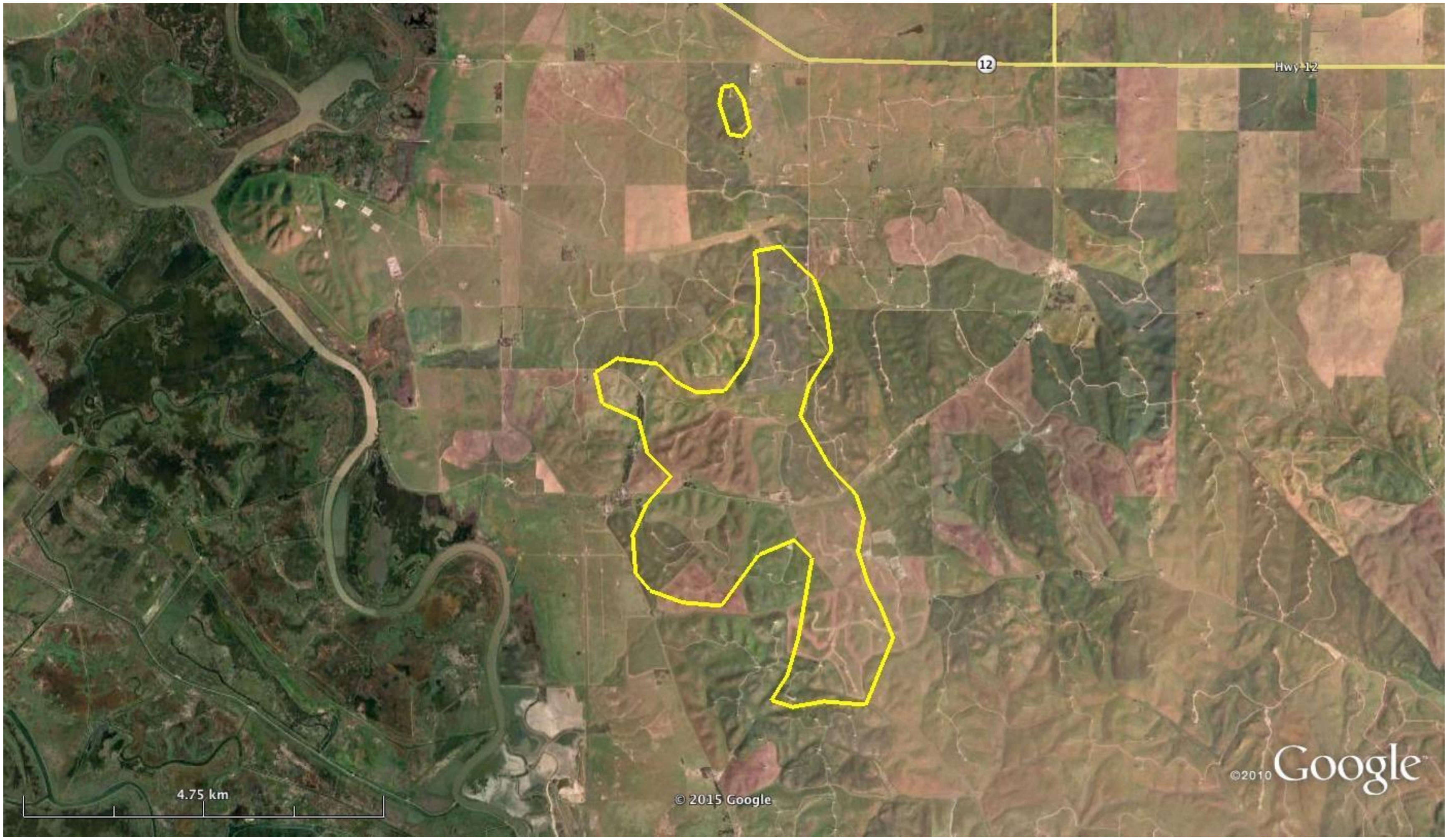


Figure 2. Northern turbines at Shiloh IV. A yellow icon indicates a turbine that was on weekly search rotation in year 2 until February 2016. A blue icon indicates a turbine that was searched in year 2 only on a monthly search rotation.

Figure 3. Middle turbines at Shiloh IV. A yellow icon indicates a turbine that was on weekly search rotation in year 2 until February 2016. A blue icon indicates a turbine that was searched in year 2 only on a monthly search rotation.

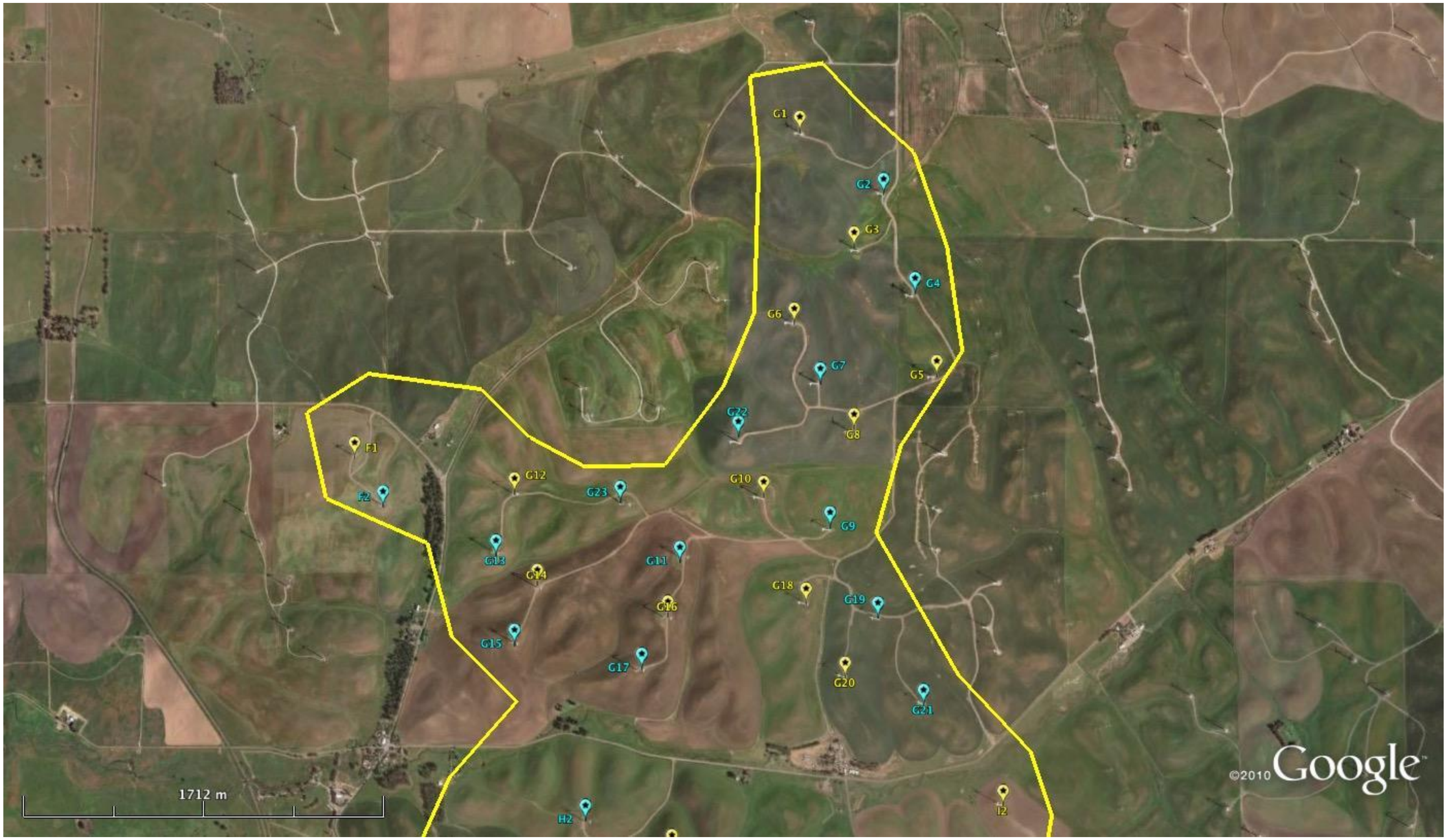
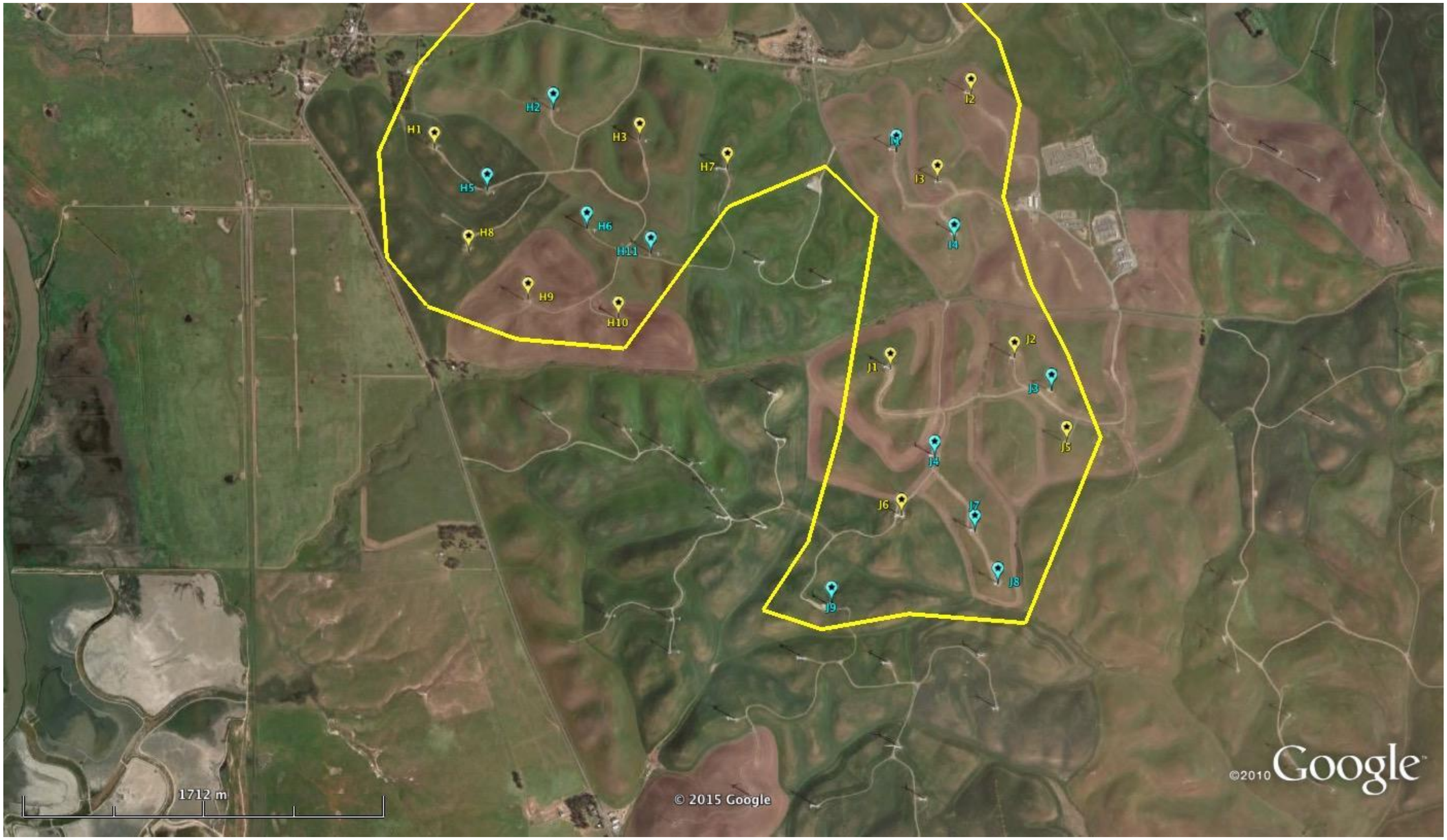


Figure 4. Southern turbines at Shiloh IV. A yellow icon indicates a turbine that was on weekly search rotation in year 2 until February 2016. A blue icon indicates a turbine that was searched in year 2 only on a monthly search rotation.



Introduction

We report the results of a second year of monthly eagle fatality monitoring (19 October 2015 to 30 September 2016) conducted at the Shiloh IV Wind Project and compare them with the first year's results (13 September 2014 to 22 August 2015), previously reported (Kerlinger et al. 2015b). The Shiloh IV Wind Project is located in the Montezuma Hills Wind Resource Area (MHWRA) in Solano County, California (Figs. 1-4). Shiloh IV has 50 turbines generating 102.5 MW at peak production (2.05 MW per turbine). Turbines began to produce electricity in December 2012. The turbines have rotor diameters of 92 m and hub heights of 78.5 m, except for five turbines that have hub heights of 68.5 m.

This monitoring was required as a condition of an eagle take permit that the U.S. Fish and Wildlife Service (hereafter, the Service) issued in July 2014. The permit allows the take (i.e., injury or killing) of a total of five Golden Eagles over five years during operations and maintenance activities. Take is allowed only during the five-year duration of the permit, but the permit is renewable. An Eagle Conservation Plan (ECP; ICF International 2014) detailed post-construction monitoring activities.

Fatality studies in the MHWRA (e.g., Kerlinger et al. 2006b, 2009b, 2012, 2015a, and 2016 at High Winds, Shiloh I, Shiloh II, Shiloh III, and Shiloh IV respectively) demonstrate that Golden Eagle fatalities are rare events. For example, there were no Golden Eagle carcasses recorded in 12,000 weekly turbine searches conducted at Shilohs II, III, and IV from April 2009 to February 2016. There was one incidental record (i.e., a record outside of searches), however, at Shiloh III on 30 December 2013. We have no information regarding the health of that eagle, so it is unsure if injury from the turbine was the ultimate cause of death.

The fatality rate of Golden Eagles in the MHWRA is demonstrably low, but demonstrating zero fatalities is virtually impossible because detection probability can never be 100%. Factors affecting detection probability include search interval, spatial coverage, temporal coverage, search efficiency, and carcass persistence. We sought to maximize these factors as stipulated in the ECP.

If monitoring shows that take has been exceeded, then adaptive management actions, called Experimental Advanced Conservation Measures defined in the eagle take permit, can be implemented to reduce take to permitted levels.

Methods

Fatality monitoring was designed to detect and document an eagle injury or mortality using standard carcass searching as specified in the USFWS Shiloh IV Eagle Take Programmatic Permit MB67633A-0. A search round consisted of searching all 50 Shiloh IV turbines out to 120 m from turbines. The 120-m distance was significant because it extended searches nearly to 124 m, which was the maximum distance that the ballistics model of Hull and Muir (2010) predicted that a large bird, having collided with wind turbines, would be distributed. The density weighted proportion (DWP; Huso and Dalthorp 2014) of large birds expected in the 120-124 m area was calculated, using a linear distance model, as 0.001. Given the gently sloping terrain and agricultural land use surrounding turbines, there was no unsearchable area out to 120 m. Thus, we estimate that searchers were able to cover 99.9% of searchable area in each search round.

For basic eagle searches (i.e., searches at turbines not in weekly search rotation; see below), the number of transects used to search each turbine depending on the height of vegetation, assessed before searches commenced. When vegetation was short, i.e., ≤ 15 cm (≤ 6 inches) in height, transects were spaced at 20 m, 60 m, and 100 m from turbines, with searchers searching 20 m on each side of transects. When vegetation was tall, i.e., > 15 cm (> 6 inches) in height, the spacing between transects was reduced to improve detectability, with transects located at 10 m, 30 m, 50 m, 70 m, 90 m, and 110 m from turbines and searchers searching 10 m on each side of transects. The division at 15 cm was based on hundreds of search efficiency (SE) trials that Curry & Kerlinger had conducted in the MHWRA (Kerlinger et al. 2006b, 2009b, 2012, 2015a, and 2016), which showed sharp reductions in SE when vegetation height exceeded 15 cm.

It is important to note that the first year and a half of this study (September 2014 to February 2016) overlapped with a required bird and bat fatality study at Shiloh IV, which employed weekly searches of 25 of the 50 turbines. During the overlap period, turbines were divided into two groups: (1) the 25 turbines in weekly search rotation, and (2) the 25 turbines not in weekly search rotation. To meet the requirements of Solano County, turbines in weekly search rotation were searched along 13 circular transects, the spacing of which did not depend on vegetation height. Transects were spaced at 10 m apart from 100 m to 30 m from turbine bases and 5 m apart between 30 m and 5 m from turbine bases. Teams of 2-4 searchers used range finders to estimate distances from turbines and recheck them periodically. To search those turbines out to 120 m for the eagle fatality study, an additional transect was added during the week when eagle searches were conducted.

Thus, monthly eagle searches at turbines searched on weekly rotation used closer transect spacing. As we demonstrate, search efficiency was greater when transects were spaced more closely. In the analysis that follows, we differentiate eagle searches based on the number of transects employed.

Eagle searches were conducted on monthly intervals. A monthly interval was chosen because evidence strongly suggested that large bird carcasses were likely to persist long enough to be found in the next search. As reported below (Table 1), in 82 carcass persistence (CP) trials conducted with Red-tailed Hawks, Turkey Vultures, and Great Horned Owls – surrogate species that approached Golden Eagles in bulk – 72% (60%, 82%) were likely to persist until the next search in short vegetation, with 89% (81%, 96%) likely to persist until the next search in tall vegetation.

Golden Eagles, however, are considerably bulkier than those surrogates, making them easier for searchers to find and more difficult for scavengers to remove. As explained in the ECP (ICF International 2014), a study that ICF International (2012) conducted in the Altamont Pass Wind Resource Area (APWRA) yielded an estimate of overall detection probability (combining search efficiency and carcass persistence) for Golden Eagles of 93% (83%, 98%) at 30 days and 81% (62%, 94%) at 60 days. ICF International generated these estimates using a model that related carcass persistence to wing area, as Golden Eagle carcasses were not available for trials. Anecdotal evidence from the APWRA suggests that Golden Eagle carcasses can persist for many years, with 9 years being the longest, based on the discovery of additional carcass parts from previously collected carcasses (H. Beeler, personal communication). The ICF study and this anecdotal evidence strengthen the justification for the monthly search interval.

To determine search efficiency (SE) and carcass persistence (CP) rates, we used data from bird and bat fatality studies at Shilohs II, III, and IV, as well as results of testing conducted in year 2 of this study. As noted, Red-tailed Hawks, Turkey Vultures and Great Horned Owls were used as surrogates for Golden Eagles. They were sourced from freezers where Curry & Kerlinger's fatality finds from MHWRA bird and bat fatality studies were stored. Carcasses were thawed completely before being placed in the field.

In year 2 of this study, 10 samples combining SE and CP testing were conducted in both short and tall vegetation at turbines only searched monthly (i.e., along 3 or 6 transects). Aaron Hasch, the field manager, distributed test carcasses at turbines scheduled to be searched the next day. Carcass placements never exceeded one per turbine, and searchers were never aware that test carcasses had been placed. Thus, if they missed a test carcass on the first round of searches, it was available to be found in the next round, if scavengers did not remove it. Carcasses were placed at distances and bearings from turbines derived from a random number generator. Hasch then checked carcasses every three days until day 60 to determine the CP rate. At day 60, all remains were removed.

SE was found to vary by transect spacing as well as by vegetation height. Thus, for eagle searches conducted at turbines in weekly search rotation along closely spaced transects, we used SE data from bird and bat fatality studies at Shilohs II, III, and IV to determine the SE rate. For eagle searches conducted at turbines in monthly search rotation, in which transects were spaced farther apart depending on vegetation height, we used SE data from sampling conducted in year 2 of this study.

CP varied by vegetation height only, not by transect spacing. We merged CP data from bird and bat fatality studies at Shilohs II, III, and IV, which were censored at 14 days, with data collected in year 2 of this study, censored at 60 days. Merging these datasets was practical because they described different sections of the CP curve. We used the Huso fatality estimator (Huso et al. 2012) to model CP.

Had an eagle carcass been found in searches or incidentally (i.e., outside of searches), it would have been documented and collected in accordance with an established protocol (see Kerlinger et al. 2016), and the Service would have been notified immediately. Other birds and bats found in areas searched only for eagles were recorded as incidental finds.

Results

Two years of monthly eagle searches at Shiloh IV (a total of 1,200 searches) recorded no Golden Eagle fatalities. Eagle searches in year 1 took place from 13 September 2014 to 22 August 2015 (Kerlinger et al. 2015b). Following a one-month hiatus, a second year of eagle searches took place from 19 October 2015 to 30 September 2016 (this report). Until 27 February 2016, a bird and bat fatality study that searched 25 of the 50 turbines on a weekly search rotation was concurrent with eagle fatality monitoring. It also recorded no Golden Eagle fatalities.

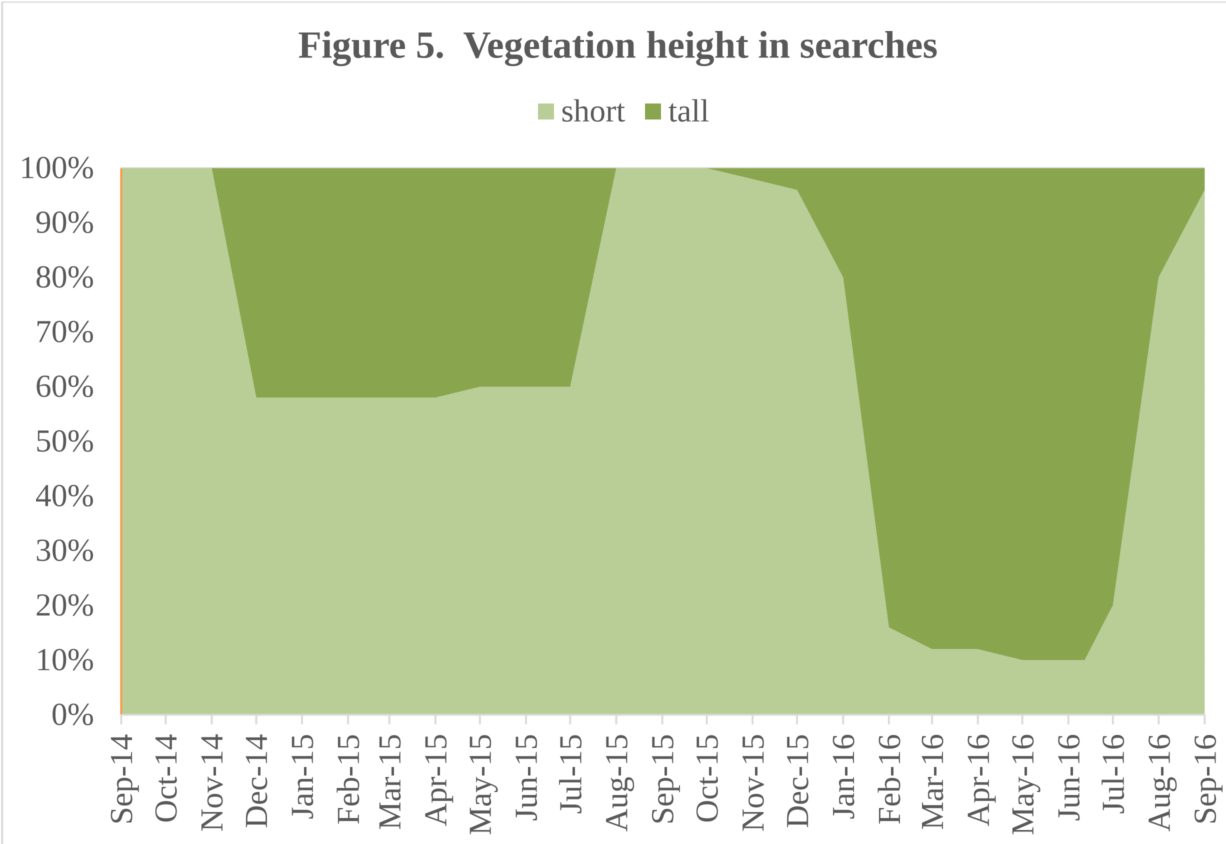
In this study, all 50 turbines were searched out to 120 m in each search round, and there were no unsearchable areas within 120 m. The 120-m distance nearly extended to 124 m, the maximum distance that the ballistics model of Hull and Muir (2010) predicts that a large-bird carcass would be distributed. As explained above, the density weighted proportion of large birds expected at 120-124 m was 0.001. Thus, near complete spatial coverage (99.9%) was achieved. Moreover, turbines were searched in every month of the year, thereby achieving complete temporal coverage.

SE varied by transect spacing and vegetation height (Table 1). As detailed in Methods, if a turbine was in the weekly search rotation for bird and bat fatalities, there were 14 closely spaced transects, between 5 and 10 m apart. If not, transect spacing depended on vegetation height, with three transects 40 m apart in short vegetation (≤15 cm in height) and six transects 20 m apart in tall vegetation (>15 cm in height).

SE was sampled using surrogates for Golden Eagle, namely, Red-tailed Hawks, Turkey Vultures, and Great Horned Owls collected in MHWRA fatality studies. The 14-transect rate was computed from data collected in 2009-2016 in bird and bat fatality studies at Shilohs II, III, and IV, with 34 samples in short vegetation and 28 samples in tall vegetation. The 3-transect and 6-transect rates were computed from 10 samples each conducted in year 2 of this study.

SE varied from 0.50 to 1.00 (Table 1). In short vegetation, the difference between 14-transect searches and 3-transect searches was extremely statistically significant (p = 0.0005). In tall vegetation, SE was significantly greater (p = 0.0252) in 14-transect searches than in 6-transect searches. In other words, closer transect spacing improved SE. Given these differences, searches were segregated by number of transects and vegetation height (Table 1).

CP was only influenced by vegetation height. Using the Huso Estimator (Huso et al. 2012), CP was modeled with a lognormal distribution based on AICc. Alternatives were Weibull, exponential, and loglogistic. CP data censored at 14 days (N = 62) was combined with year-2 data censored at 60 days (N = 20) because each dataset described different sections of the decay curve. When 14-day data were combined with 60-day data, mean CP did not appreciably change while confidence intervals tightened substantially.



The rate at which carcasses survived until the next monthly search was nearly 20% less in short vegetation than in tall vegetation (Table 1), presumably because scavengers had more difficulty finding carcasses in tall vegetation.

Visibility conditions for finding carcasses varied between years (Fig. 5; Table 1). Year 1 coincided with a prolonged drought, with 22.2% of the searches conducted in tall vegetation (>15 cm height), recorded mainly from December 2014 to July 2015. In year 2, there was more seasonal rain, resulting in 47.5% of searches conducted in tall vegetation, recorded mainly during February-July 2016.

In year 2, there were three incidental finds of avian carcasses in areas searched only for eagle carcasses. They were a Red-winged Blackbird (at turbine H1 on 23 October 2015), a Rock Pigeon (at turbine G20 on 27 July 2016), and a Red-tailed Hawk (at turbine K1 on 2 September 2016). No bat carcasses were found.

Table 1. Number and type of searches conducted each year and corresponding SE and CP (mean and 95% CI)

Year	Search type	# transects	Vegetation height	# searches	% searches	SE samples	SE	CP samples	CP
y1	bird/bat + eagle	14	short	236	39.3%	34	1.00 (0.93, 1.00)	44	0.72 (0.60, 0.82)
y1	bird/bat + eagle	14	tall	64	10.7%	28	0.86 (0.70, 0.95)	38	0.89 (0.81, 0.96)
y1	eagle only	3	short	231	38.5%	10	0.70 (0.39, 0.91)	44	0.72 (0.60, 0.82)
y1	eagle only	6	tall	69	11.5%	10	0.50 (0.22, 0.78)	38	0.89 (0.81, 0.96)
				600	100.0%				
y2	bird/bat + eagle	14	short	99	16.5%	34	1.00 (0.93, 1.00)	44	0.72 (0.60, 0.82)
y2	bird/bat + eagle	14	tall	26	4.3%	28	0.86 (0.70, 0.95)	38	0.89 (0.81, 0.96)
y2	eagle only	3	short	216	36.0%	10	0.70 (0.39, 0.91)	44	0.72 (0.60, 0.82)
y2	eagle only	6	tall	259	43.2%	10	0.50 (0.22, 0.78)	38	0.89 (0.81, 0.96)
				600	100.0%				

Discussion

As detailed (Table 1), two types of searches were used to monitor eagle fatalities with respect to take stipulated in the eagle take permit for Shiloh IV:

a) 14-transect searches conducted at the 25 turbines that were searched weekly for bird and bat fatalities. Weekly searches were a condition of the Solano County permit to construct and operate the wind farm. Because of more closely spaced transects and more frequent searching, the 14-transect searches were more likely to detect a large carcass such as an eagle than the standard 3 or 6-transect eagle search protocol.
b) 3 or 6-transect searches (depending on vegetation height) conducted at turbines that were not in weekly search rotation. This search method was outlined in the Eagle Conservation Plan (ICF International 2014).

Weekly searches terminated in February 2016, and all subsequent searches until September 2016, when year-2 monitoring ended, were 3 or 6-transect searches.

The Shiloh IV Eagle Take Permit includes a take limit of 5 eagles over 5 years. In addition, the Shiloh IV Eagle Take Permit includes Table 4-1, which describes experimental Advanced Conservation Measures based on number of eagle takes in specified numbers of years. For example, if three eagles are taken within a 5-year period, Step II would apply, which includes additional monitoring of flight patterns or use of an auditory deterrent. Based on more than two years of carcass searches in which no eagle takes were detected, the experimental ACP’s are not triggered and no stepwise additional minimization techniques are warranted.

In this report, we focused on the two 12-month cycles of monthly fatality monitoring at all turbines. Note, however, that weekly fatality monitoring at half of the turbines was conducted in July-August 2014, during the period between the issuance of the incidental take permit and the initiation of the first 12-month monitoring cycle, and in September 2015, the hiatus month between 12-month monitoring cycles. No evidence of eagle take was detected during the two months before and the month between the two 12-month eagle monitoring periods. In addition, any incidental finds by project operations and maintenance staff would have been called to the attention of biologist searchers. Consequently, the results of this study cover more than 24 months of monitoring at the facility. Based on the amount of eagle protocol searching and the opportunities for incidental finds, and the absence of any evidence of eagle mortality or injury, it appears that no take of eagles occurred at the Shiloh IV facility.

Literature cited

Hull, C., and S. Muir. 2010. Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. Australian Journal of Environmental Management 17:77–87.

Huso, M., and D. Dalthorp. 2014. Accounting for unsearched areas in estimating wind turbine-caused fatality. The Journal of Wildlife Management; DOI: 10.1002/jwmg.663.

Huso, M., N. Som, and L. Ladd. 2012. Fatality estimator user's guide. U.S. Geological Survey Data Series 729, 22 p.

ICF International. 2012. Altamont Pass Wind Resource Area Bird Fatality Study, Bird Years 2005–2010. May. Final. (ICF 00904.08.) Sacramento, CA. Prepared for Alameda County Community Development Agency, Hayward, CA.

ICF International. 2014. Eagle Conservation Plan for the Shiloh IV Wind Project, Final. Prepared for Shiloh IV Wind Project, LLC.

Kerlinger, P., R. Curry, C. Wilkerson, L. Culp, A. Hasch, and A. Jain. 2006a. Avian Monitoring Study and Risk Assessment for the Shiloh II Wind Power Project, Solano County, California. Prepared for enXco.

Kerlinger, P., R. Curry, L. Culp, A. Jain, C. Wilkerson, B. Fischer, and A. Hasch. 2006b. Post-Construction Avian and Bat Fatality Monitoring Study for the High Winds Wind Power Project, Solano County, California: Two Year Report. Prepared for High Winds, LLC, and FPL Energy.

Kerlinger, P., R. Curry, C. Wilkerson, L. Culp, A. Hasch, and A. Jain. 2009a. Avian Monitoring Study and Risk Assessment for the Shiloh III Wind Power Project, Solano County, California. Prepared for enXco.

Kerlinger, P., R. Curry, L. Culp, A. Hasch, and A. Jain. 2009b. Post-Construction Avian Monitoring Study for the Shiloh I Wind Energy Project, Solano County, California: Final Report. Prepared for Iberdrola Renewables.

Kerlinger, P., R. Curry, and A. Hasch. 2011. Avian Use Study and Risk Assessment, Shiloh IV Wind Project, Solano County, California. Prepared for enXco. 203 p.

Kerlinger, P., R. Curry, A. Hasch, J. Guarnaccia, and D. Riser-Espinoza. 2012. Post-construction bird and bat studies at the Shiloh II Wind Power Project, Solano County, California. Report prepared for EDF Renewables, USA.

Kerlinger, P., R. Curry, A. Hasch, and J. Guarnaccia. 2015a. Post-construction bird and bat studies, Shiloh III Wind Power Project, Solano County, California, final report. Prepared for Shiloh III Wind Project, LLC.

Kerlinger, P., R. Curry, A. Hasch, and J. Guarnaccia. 2015b. Eagle fatality monitoring report, Shiloh IV Wind Power Project, Solano County, California. Prepared for Shiloh IV Wind Project, LLC.

Kerlinger, P., R. Curry, A. Hasch, and J. Guarnaccia. 2016. Post-construction bird and bat studies, Shiloh IV Wind Power Project, Solano County, California, final report. Prepared for Shiloh IV Wind Project, LLC.